Conditional Compliance
Life Cycle Investment Criteria

NIST Handbook 135

WA State EUI Standard

RCW 19.27A.200 / HB 1257

Commerce Pre-rulemaking Workshop #5 : December 19th, 2019

Greg W.R. Rock
Former Commerce Staff Developer of:
Washington State Life Cycle Cost Tool

Today's Agenda (4-Hours)

- What is Life Cycle Cost Analysis (LCCA)
  - Q&A
  - Short Break
- How is LCCA standardized within RCW 19.27A.200
  - Q&A
  - Break
- Which variables matter the most to the outcome
- Lunch-Time
- Discussion Workshop – Important Investment Criteria Variables

Life Cycle Cost Analysis (LCCA) is **NOT** Life Cycle Analysis/Assessment (LCA)

- Life Cycle Analysis/Assessment (LCA) is the full accounting of the environmental source to point-of-use impacts associated with:
  - Harvesting & refining of energy
  - Material production
  - Transportation of materials
  - Construction
  - Operation
  - Demolition of a building
  - Material disposal
  - Other factors

In Contrast

LCCA is a "site boundary" operational evaluation of economic costs and savings

Life Cycle Cost Analysis (LCCA)

- Standard Business/Economic Practice
  - "The time value of money"
  - "Minimum Attractive Rate of Return"
  - "Engineering Economics"
  - "Life Cycle Cost Effective"

- Common Evaluation Metrics :
  - **Net Present Savings = NPS = (PS – PC)**
  - **Savings to Investment Ratio = SIR = (PS/PC)**

Where: P = Present, S = Savings, C = Costs
With cost and savings compared to baseline scenario

Convert future money into present money at a discount. Then add, subtract and/or divide those present values

Life Cycle Cost Analysis Narrative Description

2015 ASHRAE Standard 100 : Informative Annex H1.1 – “Life-cycle costing (LCC) is used to evaluate the **total cost of ownership** of *energy efficiency measures* (*EEMs*). LCC accounts for factors such as the **time value of money, escalation of *energy costs* over time, annual maintenance costs, component replacement costs, and the useful life of the equipment.** Other factors that may also be considered include **temporary disruption of *building* operations**.

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2011 ESSB 5931 : Public Buildings RCW – 39.35.030 (10) "**Life-cycle cost means** the initial cost and cost of operation of a major facility over its economic life. This shall be calculated as the **initial cost** plus the **operation**, **maintenance**, and **energy costs** over its **economic life**, reflecting **anticipated increases** in these costs **discounted to present value** at the **current rate for borrowing** public funds, as determined by the office of financial management.”

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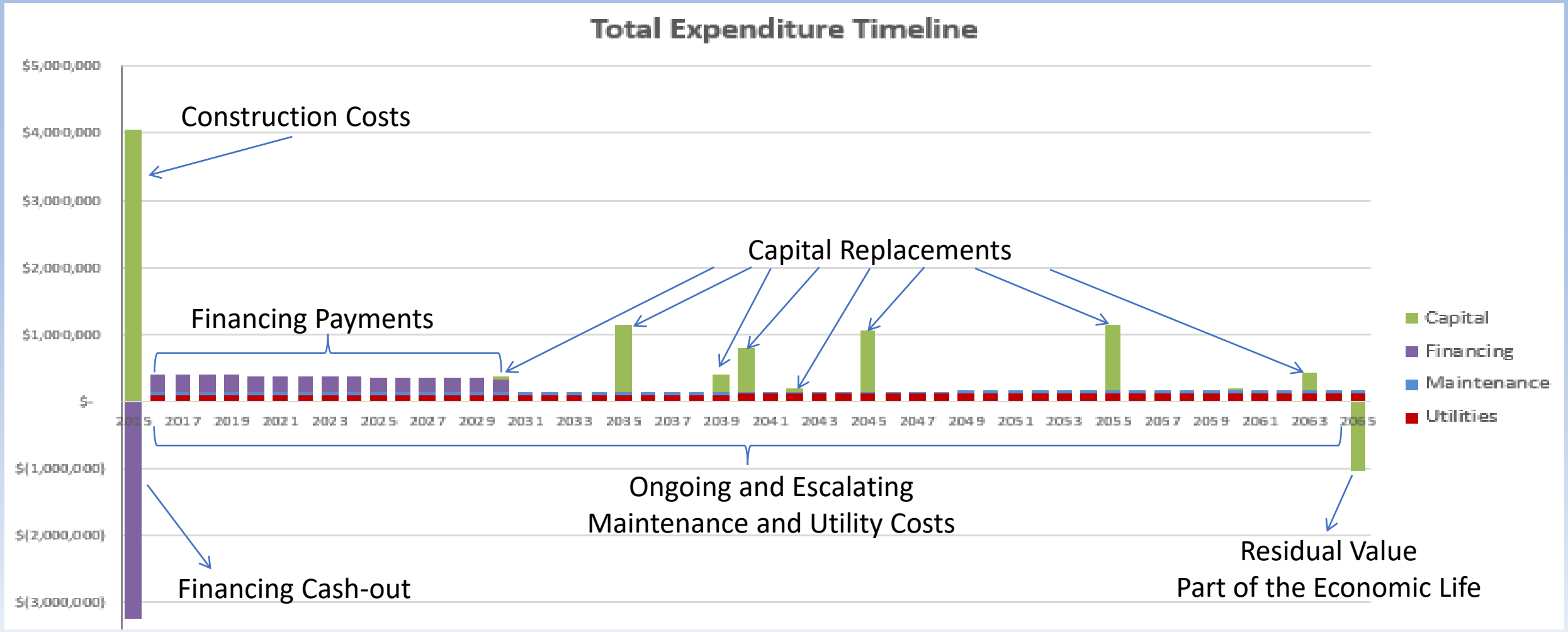
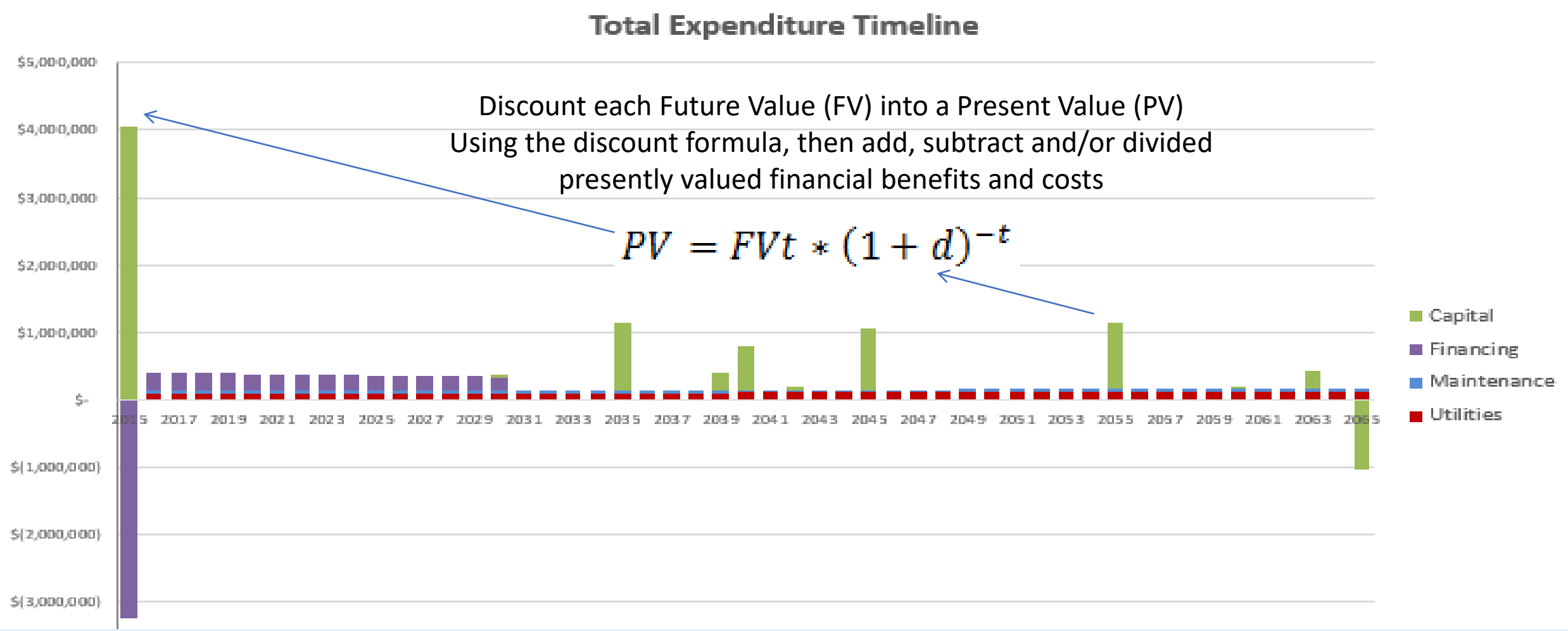
1995 NIST Handbook 135 : Life-Cycle Costing Manual

Life Cycle Costs & Benefits Timeline



Discounting Future Costs



NIST HB:135.6.2 : Savings to Investment Ratio (SIR) = Ratio of Present Valued (PV) savings to **additional** PV investment costs of the **alternative relative to the base case**

The “Base Case” / Baseline

NIST HB-135.7.1 Even a single project alternative must be evaluated against a base case. The base case for a single project alternative is **generally the "do-nothing" alternative**. This base case will typically have **no initial investment cost, but higher operational** (e.g., energy or water) costs than the project to be evaluated. In some cases the base case **may require a capital replacement** to prolong its life to the **end of the study period** selected for evaluating the project alternative.

NIST Baseline – The existing or code specified configuration to which an alternative configuration is compared to.
NIST Alternative – The operation of the building with existing components upgraded or built to exceed code

Sensitivity Analysis : Of Three Energy Efficiency Measures (EEM's)

ESCO LCCA study of DOT building completed for DES

- **SCRH-G1: 16 Year Simple Payback :**

  Weather-stripping (Headquarters): This measure will install weather-stripping on all garage doors

- **SCR4-M3: 1.5 Year Simple Payback :**

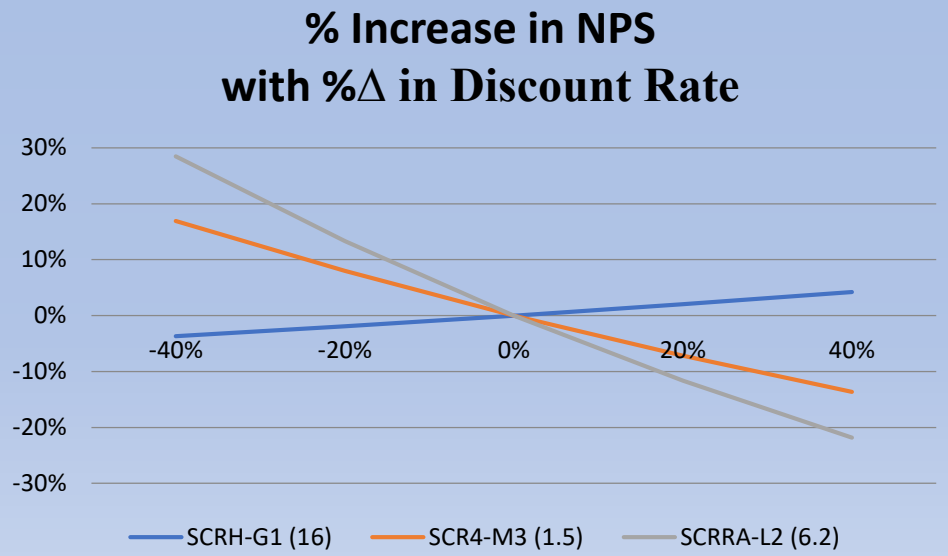
  Upgrade Thermostats (Pomeroy) – This measure will replace existing manual thermostats with new programmable communicating thermostats. The New thermostats will be tied to a central computer for remote control. This measure will integrate thermostats with lighting occupancy sensors and set back the HVAC systems when the spaces are unoccupied

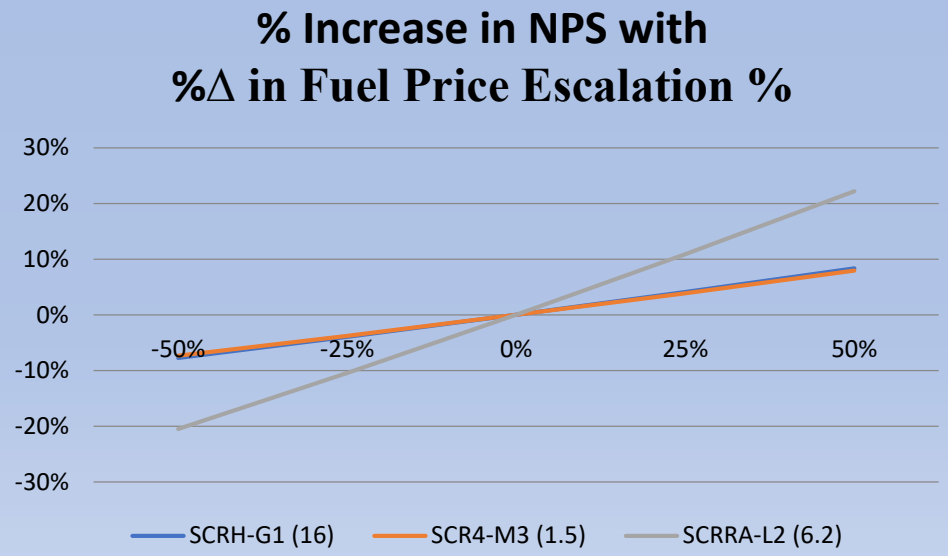
- **SCRRA-L2 : 6.2 Year Simple Payback :**

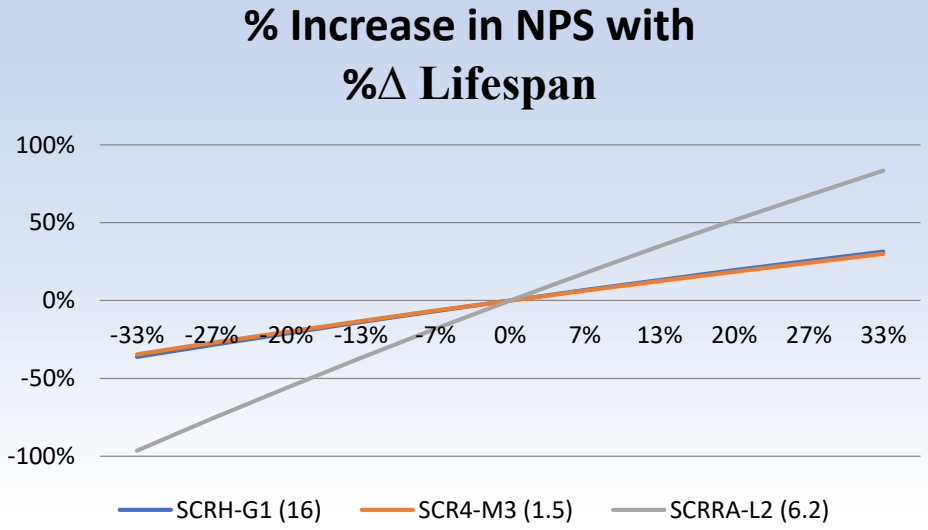
  Lighting Retrofit/Replacement – Interior & Exterior (Ryegrass) – This measure will retrofit/replace any existing T-12, magnetic ballast, incandescent, and HID lighting fixtures with new T-8, electronic ballasts and compact fluorescent technology. This measure will also incorporate occupancy sensors and day lighting controls to turn lights off when spaces are unoccupied or ambient lighting is available.

% Increase in NPS per % Change in Variable

Base Case: 5% MARR, 2% Fuel Escalation, 15 Year Study Life

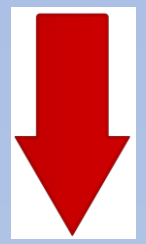




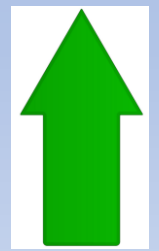


Department of Commerce
Innovation is in our nature.

Investment Criteria : Key Variable Impacts



Discount Rate : # of EEM’s



Fuel Price Escalation : # of EEM’s

Useful Life : # of EEM’s

Allowed Costs : # of EEM’s

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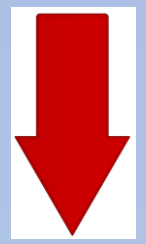

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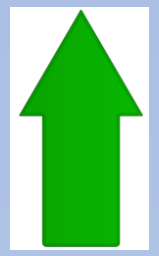

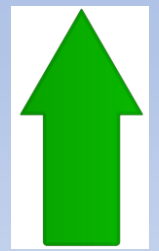

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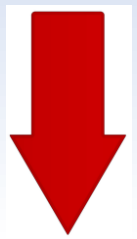

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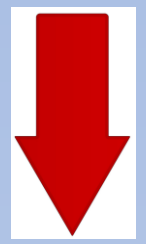

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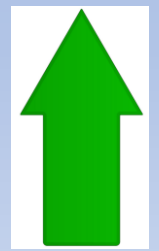

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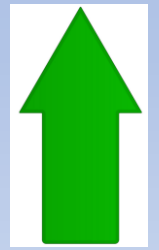

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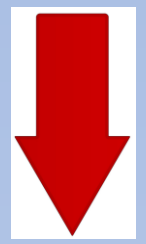

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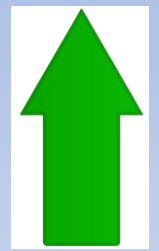

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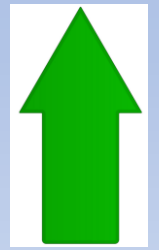

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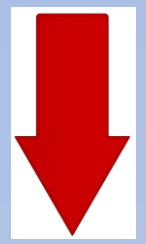

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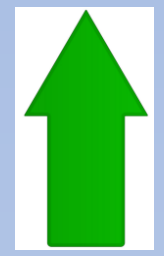

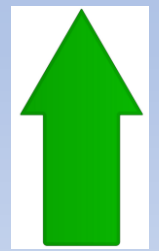

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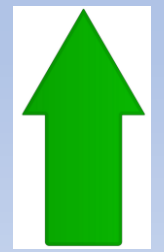

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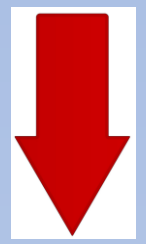

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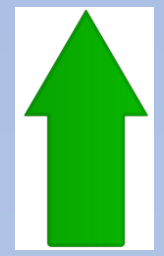

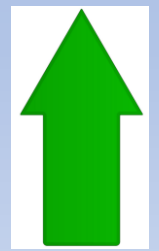

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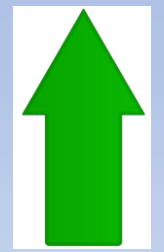

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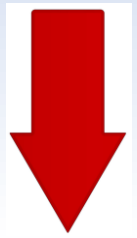


Allowed Costs : # of EEM’s


Questions


TAKE
a
stretch
BREAK

A Matryoshka of Standards

- RCW 19.27A.200 (2019)
  - Standard 100 (2015)
    - NIST Handbook 135 (1995)
      - Annual Supplement (2019) : Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis

Conditional Compliance – Investment Criteria

- RCW 19.27A.210 (d)(i) - The investment criteria must require that a building owner adopt an **implementation plan to meet the energy intensity target** or **implement an optimized bundle** of energy efficiency measures that provides maximum energy savings without resulting in a **savings-to-investment ratio of less than 1.0**, except as exempted in (d)(ii) of this subsection. The implementation plan must be based on an **investment grade energy audit** and a **life-cycle cost analysis** that accounts for the **period during which a bundle of measures will provide savings**. The building owner's **cost for implementing** energy efficiency measures must reflect **net cost, excluding any costs covered by utility or government grants**. The implementation plan **may exclude measures that do not pay for themselves over the useful life** of the measure and measures excluded under (d)(ii) of this subsection. The implementation plan may include phased implementation such that the building owner is **not required to replace a system or equipment before the end of the system or equipment's useful life**;

Highlights from RCW 19.27A.210 (d)(i)

- “The implementation plan must be based on an **investment grade energy audit and a life-cycle cost analysis** that accounts for **the period** during which a **bundle of measures** will provide savings.”
  - *Is the optimized bundle with a SIR = 1 needed to establish the study period?*
- “The building owner's cost for **implementing** energy efficiency measures must reflect **net cost, excluding any costs covered by utility or government grants**.”
  - *How is this implemented with Utility and other grant programs?*
- The implementation plan may include **phased implementation** such that the building owner is **not required to replace a system** or equipment **before the end of the** system or equipment's **useful life**;
  - *How is useful life defined for existing equipment?*
  - *How is delayed implementation reported and reviewed?*

A Conflict in RCW 19.27A.210 (d)(i)

- "The investment criteria must require that a building owner adopt an implementation plan to meet the energy intensity target or **implement an optimized bundle** of energy efficiency measures that provides **maximum energy** savings without resulting in a **savings-to-investment ratio of less than 1.0**, except as exempted in (d)(ii) of this subsection."
  - (d)(ii) *Historic features. This does not mean the whole building is exempt. Just that the individual measure impacting a historic feature is not required.*
- "The implementation plan may **exclude measures that do not pay for themselves over the useful life of the measure**"
  - *Creates a "single measure" investment criteria; not an "optimized bundle" criteria*
  - *How is the "optimized bundle" utilized within the administration and reporting procedures for the standard?*

Optimized Bundle of Efficiency Measures

Building	Existing Technology	Retrofit Technology	Electricity Savings			Natural Gas		Annua O&M Savings ($/yr)	Total Savings ($/yr)	Investment ($)	Materials Cost ($)	Labor Cost ($)	Indirect Cost ($)	Simp Payback (yrs)	SIR
			MMBtu/yr	kW Demand	$/yr	MMBtu/yr	$/yr								
E60 IMU North	Engineered Metal	4 inches Fiberglass	22	0	$1,380	718	$5,440	$0	$6,820	$120,722	$34,090	$56,407	$30,226	18	1.1
E60 IMU North (Tota	***Engineered Metal***	***5 inches Fiberglass***	***22***	***0***	***$1,380***	***718***	***$5,440***	***$0***	***$6,820***	***$120,722***	***$34,090***	***$56,407***	***$30,226***	***18***	***1.1***
B40	Built Up Roof	Increase Insulation by R-	37	0	$768	60	$337	$0	$1,105	$15,498	$5,366	$6,252	$3,880	14	1.3
J90 - Extrapolations	Built Up Roof	Increase Insulation by R-	6	2	$166	72	$401	$0	$567	$6,852	$2,372	$2,764	$1,716	12	1.5
K80	Built Up Roof	Increase Insulation by R-	35	13	$916	397	$2,221	$0	$3,137	$37,922	$13,130	$15,297	$9,495	12	1.5
K80	Built Up Roof	Increase Insulation by R-	15	6	$416	163	$914	$0	$1,330	$17,130	$5,931	$6,910	$4,289	13	1.4
A80-Extraplotations	Built Up Roof	Increase Insulation by R-	66	0	$1,363	107	$598	$0	$1,961	$27,500	$9,522	$11,094	$6,885	14	1.3
D60 Unit 10	Built Up Roof	Increase Insulation by R-	67	10	$1,765	414	$3,135	$0	$4,900	$16,644	$6,714	$5,763	$4,167	3	5.4
B40, J90, K80,	***Built up Roof***	***Increase insulation by R-***	***226***	***31***	***$5,394***	***1,213***	***$7,606***	***$0***	***$13,000***	***$121,546***	***$43,035***	***$48,080***	***$30,432***	***9***	***2.0***
B30 EC Food Service	Aluminum Frame	Add Low-e Interior Storm	32	7	$756	761	5766	$0	$6,522	$90,292	$60,651	$7,034	$22,607	14	1.2
D60 Unit 10	Aluminum Frame	Add Low-e Interior Storm	13	8	$564	375	2838	$0	$3,402	$39,226	$26,349	$3,056	$9,821	12	1.4
D60 Unit 10	Aluminum Frame	Add Low-e Interior Storm	2	1	$57	21	158	$0	$215	$2,845	$1,911	$222	$712	13	1.2
B30, D60 (Total)	***Aluminum Frame***	***Add Low-e Interior***	***47***	***16***	***$1,377***	***1,157***	***$8,762***	***$0***	***$10,139***	***$132,363***	***$88,911***	***$10,312***	***$33,140***	***13***	***1.2***
D60 Unit 10	Moderate	Install new	1	0	$9	2	$8	$0	$17	$77	$25	$41	$11	5	1.0
D70 Unit 6 Housing	Moderate	Install new	1	0	$10	2	$9	$0	$19	$77	$25	$41	$11	4	1.2
A20 Admin	Moderate	Install new	39	0	$605	-	$0	$0	$605	$3,285	$388	$2,444	$453	5	0.8
D60, D70, A20 (Tota	***Moderate***	***Install new weather***	***41***	***0***	***624***	***4***	***17***	***0***	***641***	***$3,439***	***$438***	***$2,526***	***$475***	***5***	***0.8***
A10 -Extrapolations	Vinyl or Wood Frame	Install Vinyl Frame Double	52	5	$1,034	-	$0	$0	$1,034	$51,074	$32,571	$5,715	$12,788	49	0.3
A20 Admin	Vinyl or Wood Frame	Install Vinyl Frame Double	104	11	$2,076	-	$0	$0	$2,076	$102,578	$65,417	$11,479	$25,683	49	0.3
A10, A20 (Total)	***Vinyl or Wood***	***Install Vinyl Frame***	***156***	***16***	***3110***	***-***	***0***	***0***	***3110***	***$153,652***	***$97,988***	***$17,194***	***$38,471***	***2***	***0.3***
J90 - Extrapolations	Masonry Frame Wall	R-4.1	11	3	$236	138	$773	$0	$1,009	$5,759	$1,686	$2,630	$1,442	6	3.3
K80	Masonry Frame Wall	R-4.1	36	20	$1,105	718	$4,021	$0	$5,126	$30,490	$8,928	$13,927	$7,634	6	3.2
K80	Masonry Frame Wall	R-4.1	62	17	$1,307	764	$4,277	$0	$5,584	$31,871	$9,333	$14,558	$7,980	6	3.3
K80	Masonry Frame Wall	R-4.1	72	21	$1,730	817	$4,576	$0	$6,306	$32,130	$9,409	$14,677	$8,045	5	3.7
K80	Masonry Frame Wall	R-4.1	-51	44	$246	1,020	$5,711	$0	$5,957	$27,916	$8,175	$12,752	$6,990	5	4.1
J90, K80 (Total)	***Masonry Frame***	***Increase insulation by R-***	***130***	***105***	***$4,624***	***3,457***	***$19,358***	***$0***	***$23,982***	***$128,166***	***$37,531***	***$58,544***	***$32,091***	***5***	***3.5***
Total			***622***	***168***	***$16,509***	***6,549***	***$41,183***	***0***	***$57,692***	***$659,888***	***$301,993***	***$193,063***	***$164,835***	***11***	***1.6***

Optimized Bundle of Efficiency Measures

"may exclude measures that do not pay for themselves"

Building	Existing Technology	Retrofit Technology	Electricity Savings			Natural Gas		Annua O&M Savings ($/yr)	Total Savings ($/yr)	Investment ($)	Materials Cost ($)	Labor Cost ($)	Indirect Cost ($)	Simp Payback (yrs)	SIR
			MMBtu/yr	kW Demand	$/yr	MMBtu/yr	$/yr								
E60 IMU North	Engineered Metal	4 inches Fiberglass	22	0	$1,380	718	$5,440	$0	$6,820	$120,722	$34,090	$56,407	$30,226	18	1.1
E60 IMU North (Tota	***Engineered Metal***	***5 inches Fiberglass***	***22***	***0***	***$1,380***	***718***	***$5,440***	***$0***	***$6,820***	***$120,722***	***$34,090***	***$56,407***	***$30,226***	***18***	***1.1***
B40	Built Up Roof	Increase Insulation by R-	37	0	$768	60	$337	$0	$1,105	$15,498	$5,366	$6,252	$3,880	14	1.3
J90 - Extrapolations	Built Up Roof	Increase Insulation by R-	6	2	$166	72	$401	$0	$567	$6,852	$2,372	$2,764	$1,716	12	1.5
K80	Built Up Roof	Increase Insulation by R-	35	13	$916	397	$2,221	$0	$3,137	$37,922	$13,130	$15,297	$9,495	12	1.5
K80	Built Up Roof	Increase Insulation by R-	15	6	$416	163	$914	$0	$1,330	$17,130	$5,931	$6,910	$4,289	13	1.4
A80-Extraplotations	Built Up Roof	Increase Insulation by R-	66	0	$1,363	107	$598	$0	$1,961	$27,500	$9,522	$11,094	$6,885	14	1.3
D60 Unit 10	Built Up Roof	Increase Insulation by R-	67	10	$1,765	414	$3,135	$0	$4,900	$16,644	$6,714	$5,763	$4,167	3	5.4
B40, J90, K80,	***Built up Roof***	***Increase insulation by R-***	***226***	***31***	***$5,394***	***1,213***	***$7,606***	***$0***	***$13,000***	***$121,546***	***$43,035***	***$48,080***	***$30,432***	***9***	***2.0***
B30 EC Food Service	Aluminum Frame	Add Low-e Interior Storm	32	7	$756	761	5766	$0	$6,522	$90,292	$60,651	$7,034	$22,607	14	1.2
D60 Unit 10	Aluminum Frame	Add Low-e Interior Storm	13	8	$564	375	2838	$0	$3,402	$39,226	$26,349	$3,056	$9,821	12	1.4
D60 Unit 10	Aluminum Frame	Add Low-e Interior Storm	2	1	$57	21	158	$0	$215	$2,845	$1,911	$222	$712	13	1.2
B30, D60 (Total)	***Aluminum Frame***	***Add Low-e Interior***	***47***	***16***	***$1,377***	***1,157***	***$8,762***	***$0***	***$10,139***	***$132,363***	***$88,911***	***$10,312***	***$33,140***	***13***	***1.2***
D60 Unit 10	Moderate	Install new	1	0	$9	2	$8	$0	$17	$77	$25	$41	$11	5	1.0
D70 Unit 6 Housing	Moderate	Install new	1	0	$10	2	$9	$0	$19	$77	$25	$41	$11	4	1.2
~~A20 Admin~~	~~Moderate~~	~~Install new~~	~~39~~	~~0~~	~~$605~~	~~-~~	~~$0~~	~~$0~~	~~$605~~	~~$3,285~~	~~$388~~	~~$2,444~~	~~$453~~	~~5~~	~~0.8~~
~~D60, D70, A20 (Tota~~	***~~Moderate~~***	***~~Install new weather~~***	***~~41~~***	***~~0~~***	***~~624~~***	***~~4~~***	***~~17~~***	***~~0~~***	***~~641~~***	***~~$3,439~~***	***~~$438~~***	***~~$2,526~~***	***~~$475~~***	***~~5~~***	***~~0.8~~***
~~A10 -Extrapolations~~	~~Vinyl or Wood Frame~~	~~Install Vinyl Frame Double~~	~~52~~	~~5~~	~~$1,034~~	~~-~~	~~$0~~	~~$0~~	~~$1,034~~	~~$51,074~~	~~$32,571~~	~~$5,715~~	~~$12,788~~	~~49~~	~~0.3~~
~~A20 Admin~~	~~Vinyl or Wood Frame~~	~~Install Vinyl Frame Double~~	~~104~~	~~11~~	~~$2,076~~	~~-~~	~~$0~~	~~$0~~	~~$2,076~~	~~$102,578~~	~~$65,417~~	~~$11,479~~	~~$25,683~~	~~49~~	~~0.3~~
~~A10, A20 (Total)~~	***~~Vinyl or Wood~~***	***~~Install Vinyl Frame~~***	***~~156~~***	***~~16~~***	***~~3110~~***	***~~-~~***	***~~0~~***	***~~0~~***	***~~3110~~***	***~~$153,652~~***	***~~$97,988~~***	***~~$17,194~~***	***~~$38,471~~***	***~~2~~***	***~~0.3~~***
J90 - Extrapolations	Masonry Frame Wall	R-4.1	11	3	$236	138	$773	$0	$1,009	$5,759	$1,686	$2,630	$1,442	6	3.3
K80	Masonry Frame Wall	R-4.1	36	20	$1,105	718	$4,021	$0	$5,126	$30,490	$8,928	$13,927	$7,634	6	3.2
K80	Masonry Frame Wall	R-4.1	62	17	$1,307	764	$4,277	$0	$5,584	$31,871	$9,333	$14,558	$7,980	6	3.3
K80	Masonry Frame Wall	R-4.1	72	21	$1,730	817	$4,576	$0	$6,306	$32,130	$9,409	$14,677	$8,045	5	3.7
K80	Masonry Frame Wall	R-4.1	-51	44	$246	1,020	$5,711	$0	$5,957	$27,916	$8,175	$12,752	$6,990	5	4.1
J90, K80 (Total)	***Masonry Frame***	***Increase insulation by R-***	***130***	***105***	***$4,624***	***3,457***	***$19,358***	***$0***	***$23,982***	***$128,166***	***$37,531***	***$58,544***	***$32,091***	***5***	***3.5***
Recalculate Bundel			***~~622~~***	***~~168~~***	***~~$16,509~~***	***~~6,549~~***	***~~$41,183~~***	***0***	***~~$57,692~~***	***~~$659,888~~***	***~~$301,993~~***	***~~$193,063~~***	***~~$164,835~~***	***~~11~~***	***~~1.6~~***

The State Law Names Standard 100

- RCW 19.27A.210 : The standard must include energy use intensity targets by building type and methods of conditional compliance that include an energy management plan, operations and maintenance program, energy efficiency audits, and investment in energy efficiency measures designed to meet the targets. The department shall use **ANSI/ASHRAE/IES standard 100-2018 as an initial model for standard development.** The department must update the standard by July 1, 2029, and every five years thereafter.

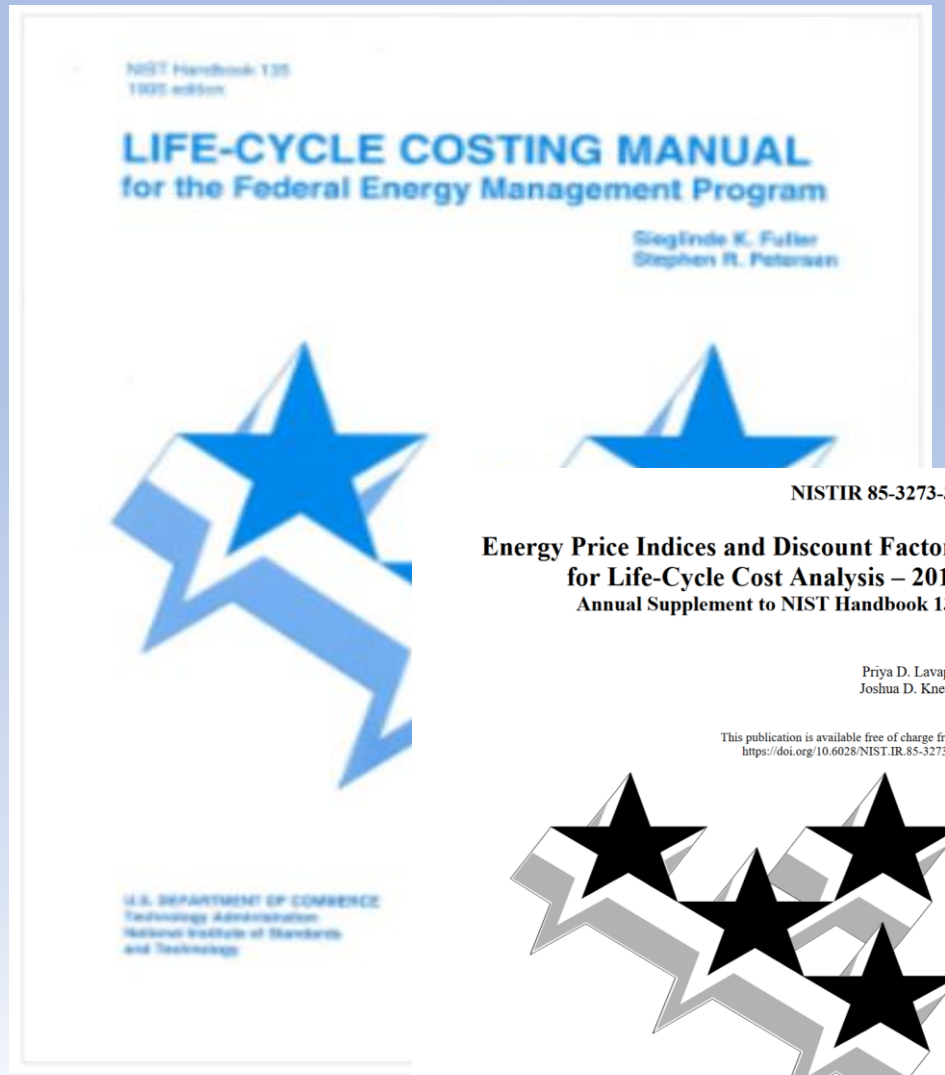
Standard 100 Names NIST Handbook 135

Informative Annex H-1.3 : Life-cycle cost analysis should follow the National Institute of Standards and Technology **(NIST) *Life-Cycle Costing Manual"***

Chapter 9.1.1.2.2 **:** Federal *buildings* shall follow the National Institute of Standards and Technology (NIST) Building Life-Cycle Cost (BLCC) Program, and the ***optimized bundle* of *EEMs* shall use all *EEMs* with a savings to investment ratio (SIR) to meet federal requirements.**

National Institute of Standards and Technology - Handbook 135

A guide to understanding the **life-cycle cost (LCC) methodology** and criteria established by the Federal Energy Management Program (FEMP) for the economic evaluation of **energy and water conservation projects** and renewable energy projects in all federal buildings. It expands on the life-cycle cost methods and criteria contained in the FEMP rules published in 10 CFR 436, Subpart A, which applies to all federal agencies. The purpose of this handbook is to **facilitate the implementation** of the FEMP rules by explaining the LCC method, **defining the measures of economic performance** used, **describing the assumptions and procedures to follow** in performing evaluations, giving examples, and noting NIST computer software available for computation and reporting purposes.



NIST HB:135.6.2 : Savings to Investment Ratio

SIR = The ratio of Present Valued (PV) savings to **additional** PV investment costs of the **alternative** relative to the **base case**

The Savings to Investment Ratio (SIR) is a **measure of economic performance** for a project alternative that expresses the **relationship between its savings and its increased investment cost (in present value terms) as a ratio.** It is a variation of the Benefit-to-Cost Ratio for use when benefits occur primarily as reductions in operation-related costs. Like the Net Savings (NS) measure, SIR is a relative measure of performance; that is, it can only be **computed with respect to a designated base case**. This means that the **same base date, study period, and discount rate** must be used **for both the base case and the alternative.** A project alternative is generally considered **economically justified** relative to a designated base case when its **SIR is greater than 1.0**. This is equivalent to saying that its savings are greater than its incremental investment costs, and that its **net savings are greater than zero**.

Savings to Investment Ratio : Simplified

When the base case is “do nothing”

$$SIR = \frac{All\ Presently\ Valued\ Savings}{All\ Presently\ Valued\ Costs}$$

NIST HB:135.6.2 : Savings to Investment Ratio

$$SIR_{A:BC} = \frac{\sum_{t=0}^{N} S_t \,/\, (1+d)^t}{\sum_{t=0}^{N} \Delta I_t \,/\, (1+d)^t}$$

S_t	=	Savings in year t in operational costs attributable to the alternative,
ΔI_t	=	Additional investment-related costs in year t attributable to the alternative,
t	=	Year of occurrence (where 0 is the base date),
d	=	Discount rate, and
N	=	Length of study period.

$$SIR_{A:BC} = \frac{\Delta E + \Delta W + \Delta OM\&R}{\Delta I_o + \Delta Repl - \Delta Res}$$

Where all amounts are in present values

ΔE	=	$(E_{BC} - E_A)$	Savings in energy costs attributable to the alternative,
ΔW	=	$(W_{BC} - W_A)$	Savings in water costs attributable to the alternative,
$\Delta OM\&R$	=	$(OM\&R_{BC} - OM\&R_A)$	Difference in OM&R costs,
ΔI_0	=	$(I_A - I_{BC})$	Additional initial investment cost required for the alternative relative to the base case,
$\Delta Repl$	=	$(Repl_A - Repl_{BC})$	Difference in capital replacement costs,
ΔRes	=	$(Res_A - Res_{BC})$	Difference in residual value, and

SIR Example : New HVAC – Chilled Beams

Baseline Costs & Annual Savings

Office of Financial Management
Olympia, Washington - Version: 2015-G
Life Cycle Cost Analysis Tool

Total Building Annual Utility Analysis	Electricity (KWH)	Natural Gas (Therms)
Annual Utility Bill [$]	$ 91,703	$ 22,116
Annual Utility Consumption Not Entered Below	827,022	24,328
Sum of Annual Utility Consumption Below	-	-
Total Annual Utility Consumption	827,022	24,328
Annual Utility Bill ÷ Total Utility Consumption	$ 0.11	$ 0.91

Uniformat II Elemental Classification for Buildings (Building Component List)		# of Units	Useful Life (Yrs.)	Installed Cost ($/Unit)	1st Year Maintenance Cost ($/Unit)	Annual Electricity (KWH/Unit)	Annual Natural Gas (Therm/Unit)
Primary Entries Below: # of Units must be > 0 to be counted; Useful Life must be >= 2						Entries Below for Component Sp	
G	**Building Code Minimum HVAC**						
X901001	1st Cost	1	50	$1,167,100.00	$32,640.00		
X901002	15 Year Components	1	15	$40,600.00			
X901003	20 Year Components	1	20	$805,800.00			
X901004	24 Year Components	1	24	$191,500.00			
X901005	25 Year Components	1	25	$1,007,800.00			
X901006	27 Year Components	1	27	$70,000.00			
X901007	30 Year Components	1	30	$781,000.00			

Alternative Costs & Annual Savings

Total Building Annual Utility Analysis	Electricity (KWH)	Natural Gas (Therms)
Annual Utility Bill [$]	$ 80,137	$ 14,732
Annual Utility Consumption Not Entered	737,675	14,732
Sum of Annual Utility Consumption Below	-	-
Total Annual Utility Consumption	737,675	14,732
Annual Utility Bill ÷ Total Utility Consumption	$ 0.11	$ 1.00

# of Units	Useful Life (Yrs.)	Installed Cost ($/Unit)	1st Year Maintenance Cost ($/Unit)	Annual Electricity (KWH/Unit)	Annual Natural Gas (Therm/Unit)
be counted; Useful Life must be >= 2				Entries Below for Component Sp	
1	50	$1,193,650.00	$36,210.00		
1	15	$30,300.00			
1	20	$988,700.00			
1	24	$258,975.00			
1	25	$661,450.00			
1	27	$50,450.00			
1	30	$1,100,000.00			

Life Cycle Cost Analysis

Alternative	Baseline	Alt. 1	Difference
1st Construction	$ 4,063,800	$ 4,283,525	$ (219,725)
PV of Capital Replacements	$ 5,964,183	$ 6,162,645	$ (198,462)
PV of Maintenance	$ 1,250,545	$ 1,387,323	$ (136,778)
		Total Increased PV Costs	**$ (554,965)**
PV of Utility Costs	$ 3,725,021	$ 3,057,985	**$ 667,037**

$$SIR = \frac{\$667,037}{\$554,965} = 1.2$$

Summary of NIST HB-135 Methodology

- Metrics & Formulas (Savings to Investment Ratio) : Standardized by HB135
- Base Case : “Do nothing” for single component measure, replace with code minimum or existing at end of life until the end of the study period.
- Study Life : Matches the longest component life in package
- Packaging : Encourages leveraging savings in one energy efficiency measure to help pay for another lower SIR measure
- Residual Value: Included in SIR calculations
  - The remaining value of an existing component at the end of study period.
  - Straight Line Depreciation based on Useful Life
- End of Life Component Replacement: Limited Rules
  - In Base Case – What is an existing component replaced with at the end of its useful life if the study period has not ended? Existing component, code-minimum, most cost effective. . .
- Timing of Costs & Benefits : All occur at the end of the calendar year
- Existing components outlasting their Useful Life: Limited Rules
  - Important Given: RCW 19.27A.210 (d)(i) Building owner is not required to replace a system or equipment before the end of the system or equipment's useful life

NIST HB-135 + Annual Supplement Assumptions

- Discount Rate: Updated annually by NIST Fuel Price Indices & Discount Factors
  - (A Different Federal Building Application)
- Fuel Prices : Updated annually by NIST for Federal buildings and contracts
  - Regional which may miss-predict Washington's changing energy marketplace
  - NIST Census Region 4: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, **Washington**, Wyoming
- EEM Useful Life: Limited Rules
  - (WA Best Practice Standardization Needed)
- EEM Capital Costs: Limited Rules
  - (WA Best Practice Standardization Needed)
  - Does an "Investment Grade Audit" mean you have "Bids in Hand"?
- EEM Maintenance Costs : Limited Rules
  - (WA Best Practice Standardization Needed)
- What are included "Implementation Cost"
  - (Needs Defining)
- What is the Base Case
  - (Needs Defining)

What Does a "Minimum Implementation" Building Owner Likely Do?

1. Benchmark & check if EUIt is in compliance
2. Implement O&M Low/No Cost Savings
3. Targeted Audits and Projects (Low-hanging fruit)
4. - If Building still miss EUIt -
5. Hire a Qualified Energy Auditor
6. Receive an "Investment Grade Audit"
   - For an "Optimized Bundle" of EEM's
   - Optimized bundle delivers roughly a SIR = 1
   - Inputs = Measure Life, Measure Costs, Measure Savings
   - LCCA Utilizes Discount Rate, Fuel Escalator & other assumptions standardized by rule-making
7. Implement the minimum number of measures to achieve EUIt or . . .
8. Building owner can as desired
   a) Removes any measures with a SIR < 1
      - Structurally weakens the investment criteria so as to not deliver a true "cost-effective" test for an optimized bundle.
      - Creates a measure by measure cost effectiveness test with individual measure savings leveraged towards profits rather than deeper energy efficiency investments
      - Essentially guarantees all "minimum implementation" projects will have SIR much greater than 1.
      - All "minimum implementation" projects will save more presently valued money than they cost
   b) Delay the installation of EEM's until the component being replaced has reached its useful life
      - Could potentially delay implementation of high SIR measures for 10+ years

TAKE
A
BREAK

NIST HB-135 + Annual Supplement Assumptions

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- What is the Base Case
  - (Needs Defining)

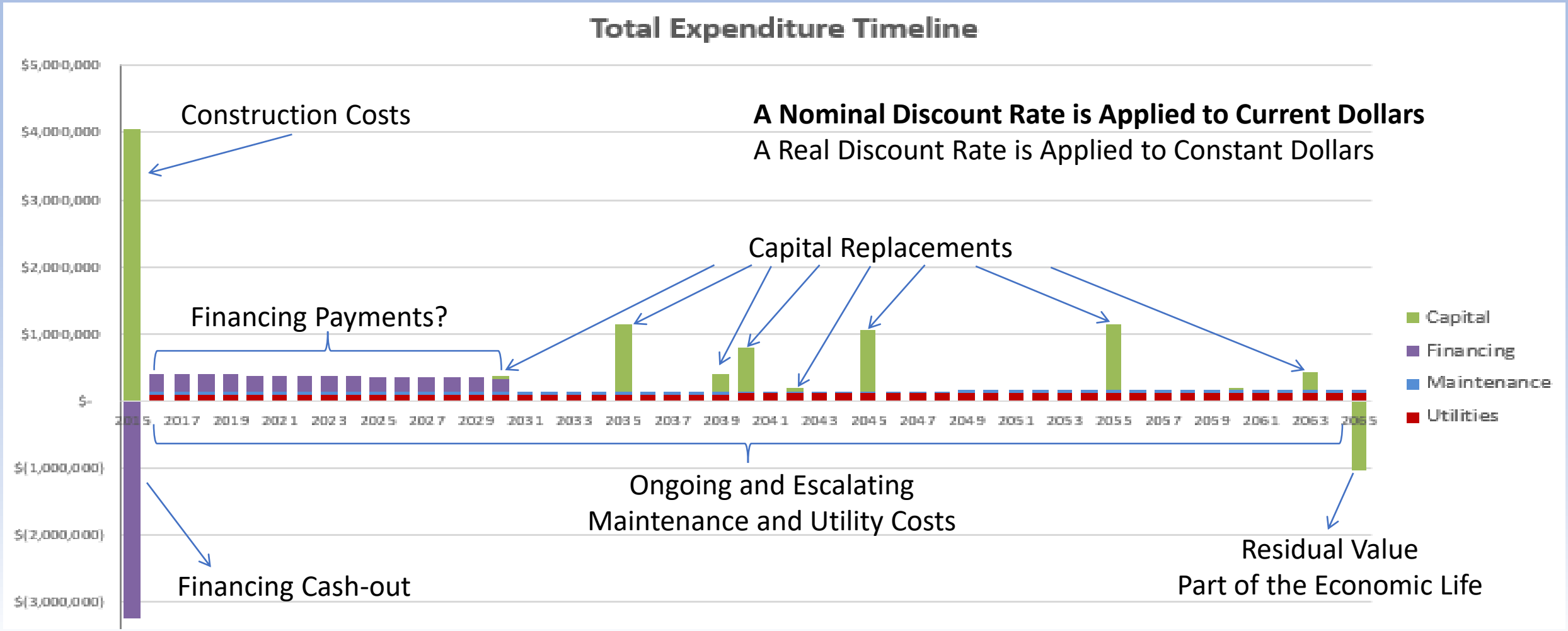
Break-Out Discussions

1. Financial Hardship Criteria
2. Covered/Included Costs & Base-Case
3. Useful Life, Capital & Maintenance Costs
4. Discount Rate & Fuel Escalation Rates

Financial Hardship Exemption

RCW 19.27A.210 (7)(c)(vi) The building meets at least one of the following conditions of financial hardship: (A) The building had arrears of property taxes or water or wastewater charges that resulted in the building's inclusion, within the prior two years, on a city's or county's annual tax lien sale list; (B) the building has a court appointed receiver in control of the asset due to financial distress; (C) the building is owned by a financial institution through default by a borrower; (D) the building has been acquired by a deed in lieu of foreclosure within the previous twenty-four months; (E) the building has a senior mortgage subject to a notice of default; or **(F) other conditions of financial hardship identified by the department by rule.**

What Costs can be Included in the Investment Criteria?



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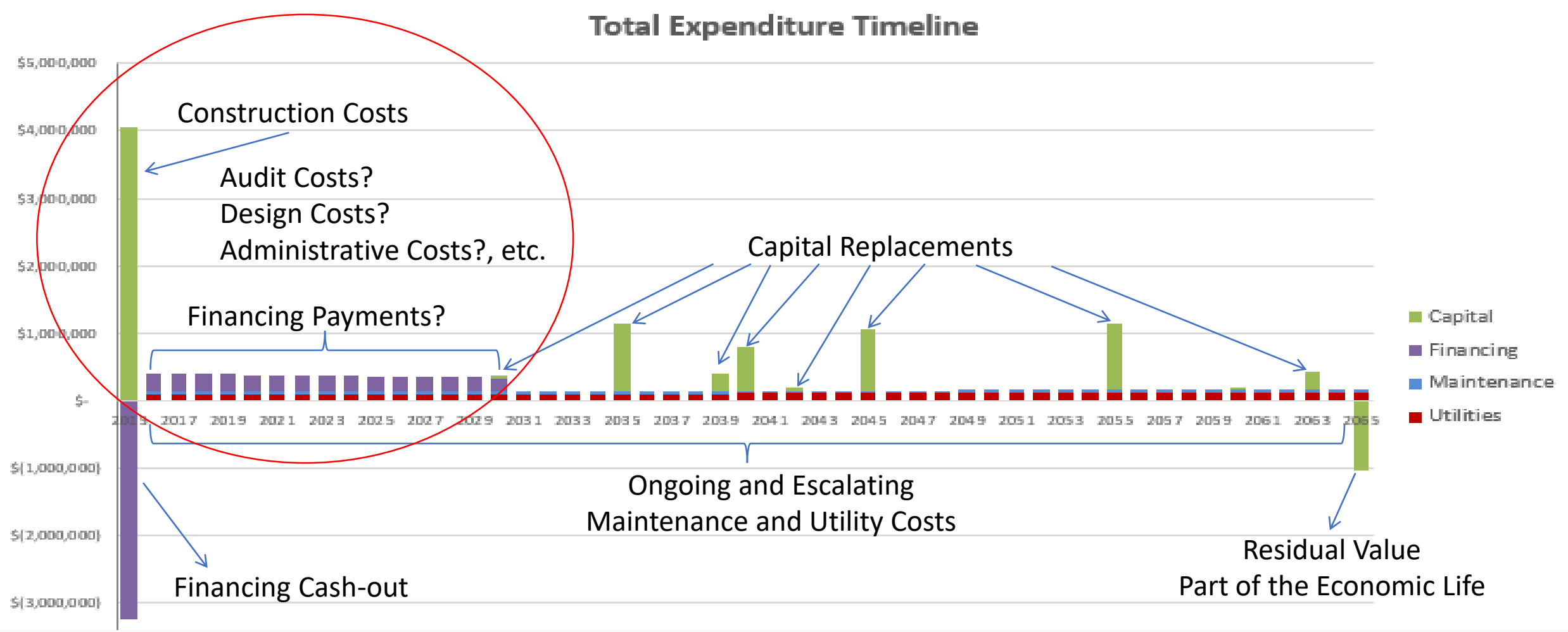


Useful Life, Capital & Maintenance Cost WA Best Practice Standardization

1. Shout out your ideas for references or methods to **Standardize Useful Lives**

Useful Life, Capital & Maintenance Cost WA Best Practice Standardization

1. Shout out your ideas for references or methods to **Standardize Useful Lives**

2. Shout out your ideas for references or methods to **Standardize Capital Costs**

Useful Life, Capital & Maintenance Cost WA Best Practice Standardization

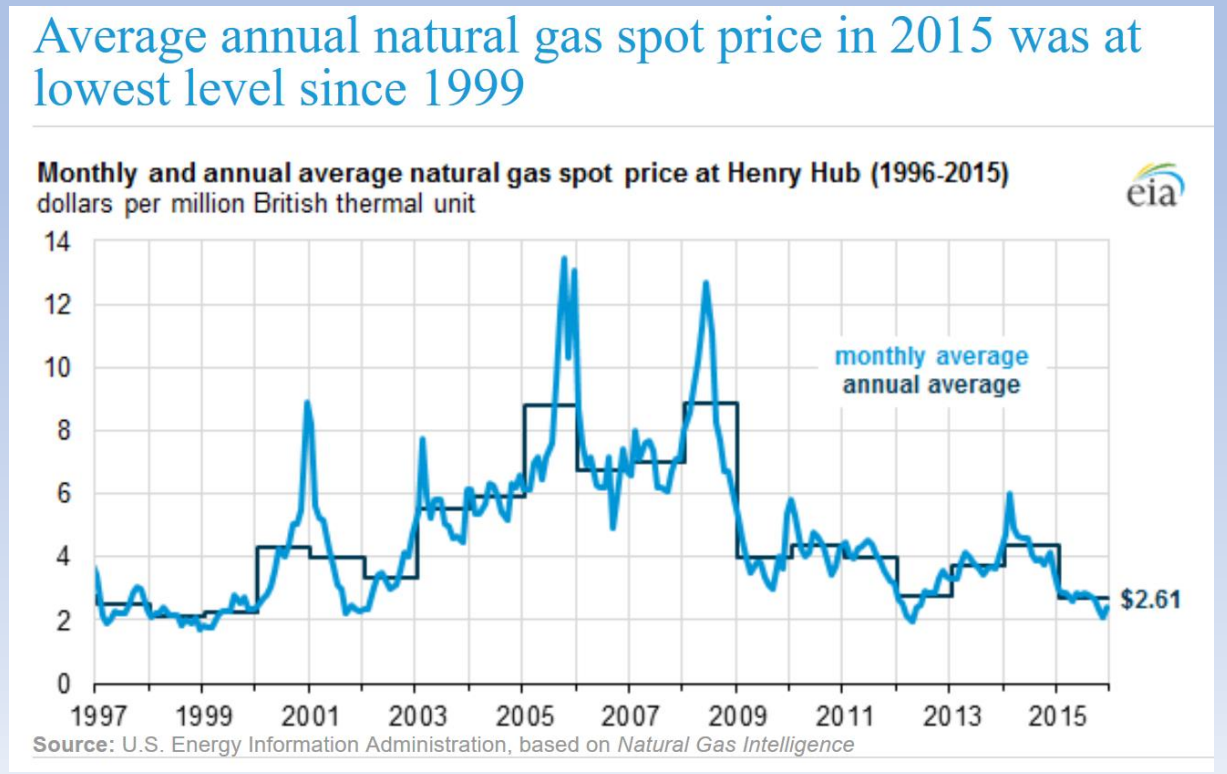
1. Shout out your ideas for references or methods to **Standardize Useful Lives**

2. Shout out your ideas for references or methods to **Standardize Capital Costs**

3. Shout out your ideas for references or methods to **Standardize Maintenance Costs**

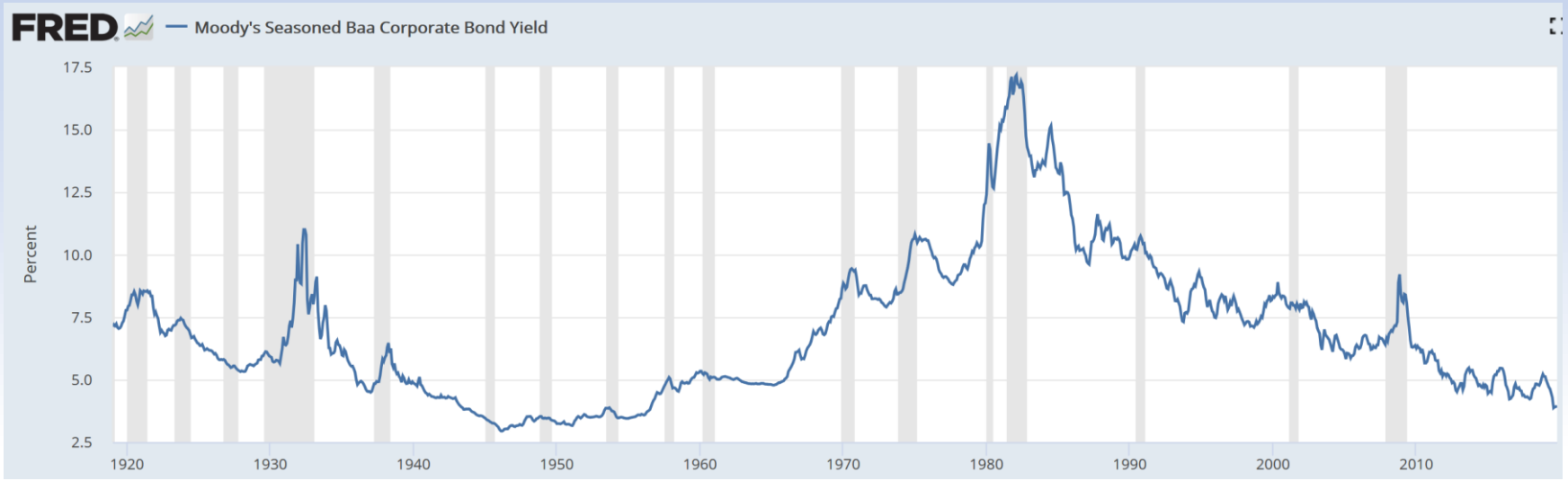
Fuel Price Escalation Rates

- What is most appropriate?
  - Adopt Federal Annual Updates?
    - Census Region 4: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming
  - Adopt Local Energy Forecasts?
  - Develop Forecasts Specifically for this Rule?
- What is administratively feasible?



Discount Rate – The Big One

- Shifts the entire LCCA by changing the influence time has over the value of money
- Established values currently exist for the federal and state perspective, but not public
- Should change over time with changing market conditions



Discount Rate : DOE / FEMP / 10 CFR 436 NIST Handbook 135 : Annual Supplemental

The **DOE nominal discount rate is based on long-term Treasury bond rates averaged over the 12 months** prior to the preparation of this report. The nominal, or market, rate is converted to a real rate to correspond with the constant-dollar analysis approach used in most federal life-cycle cost (LCC) analyses. The method for calculating the real discount rate from the nominal discount rate is described in 10 CFR 436 and uses the projected rates of general inflation published in the most recent Report of the President's Economic Advisors, Analytical Perspectives. **The procedure would result in a discount rate for 2019 lower than the 3.0 % floor prescribed in 10 CFR 436.** Thus the 3.0 % floor is used as the real discount rate for FEMP analyses in 2019. The implied long-term average rate of inflation based on the real discount rate (3.0%) and nominal discount rate (3.1%) was calculated as 0.1%. **Federal agencies and contractors to federal agencies are required by 10 CFR 436 to use the DOE discount rates when conducting LCC analyses** related to energy conservation, renewable energy resources, and water conservation projects for federal facilities.

Real rate (excluding general price inflation):	3.0%
Nominal rate (including general price inflation):	3.1%
Implied long-term average rate of inflation:	0.1%

Discount Rate : OMB Cost Effectiveness Studies NIST Handbook 135 : Annual Supplemental

The Office of Management and Budget (OMB) **discount rates for cost-effectiveness** and lease-purchase studies are based on **interest rates on Treasury Notes and Bonds** with maturities ranging from 3 to 30 years. Currently (as of April 2019) six maturities have been specifically identified by OMB, and are shown here with the corresponding real interest rate to be used as the discount rate for studies subject to OMB Circular A-94.

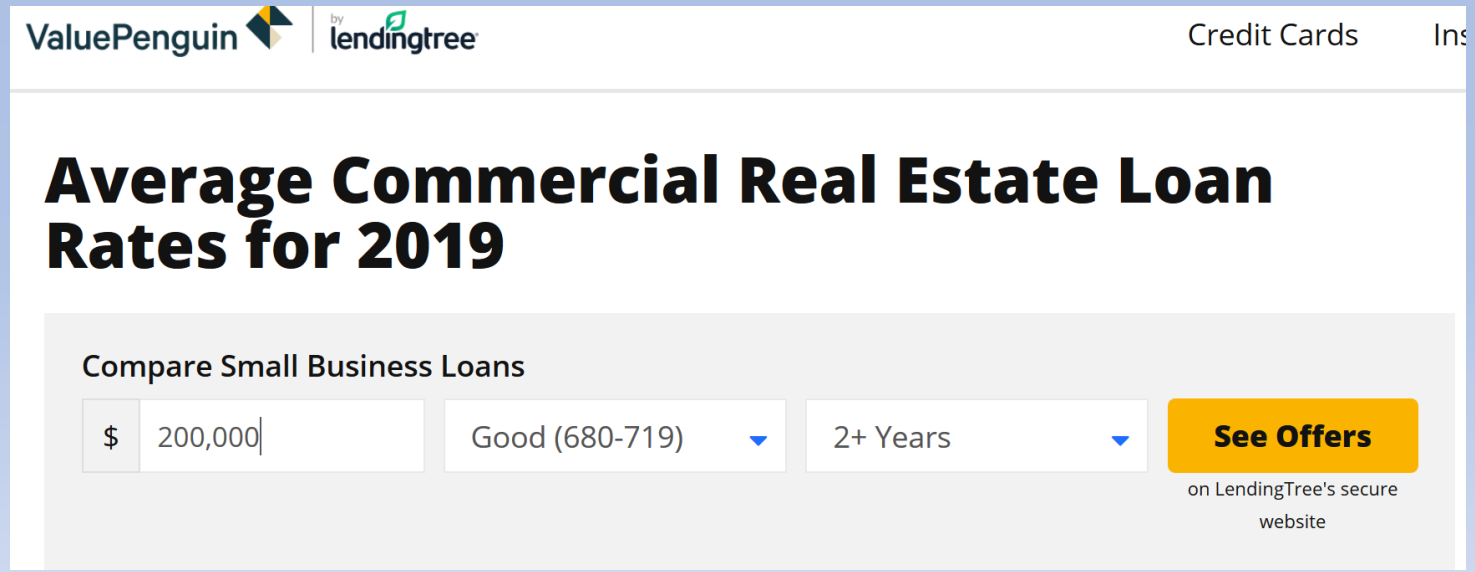
Maturity:	3-year	5-year	7-year	10-year	20-year	30-year
Rate:	1.3%	1.3%	1.3%	1.4%	1.5%	1.5%

OMB suggests that the actual **discount rate for an economic analysis be interpolated from these maturities and rates, based on the study period** used in the analysis

Discount Rate : Editorial Description
NIST Handbook 135 : Annual Supplemental

In **every-day business activities**, discount rates are **usually based on market interest rates**, that is, **nominal interest rates** which include the investor's expectation of general inflation. Market interest rates generally serve as the basis for the selection of a **nominal discount rate, which is used to discount future costs expressed in current dollars.** In contrast, the real discount rate needed to discount constant dollar amounts to present value reflects only the real **earning power of your money**, not the rate of general inflation.

Discount Rate : Commercial Lending Rates



For 2019, the **average interest rate on a commercial real estate loan is around 4% to 5%.** The actual interest rate you secure on a loan depends on the **type of loan you choose, your qualifications as a borrower, and the type of building or project** you're financing. To help you compare rates, we reviewed over a dozen types of loans and properties to compile the average interest rates for commercial mortgages.

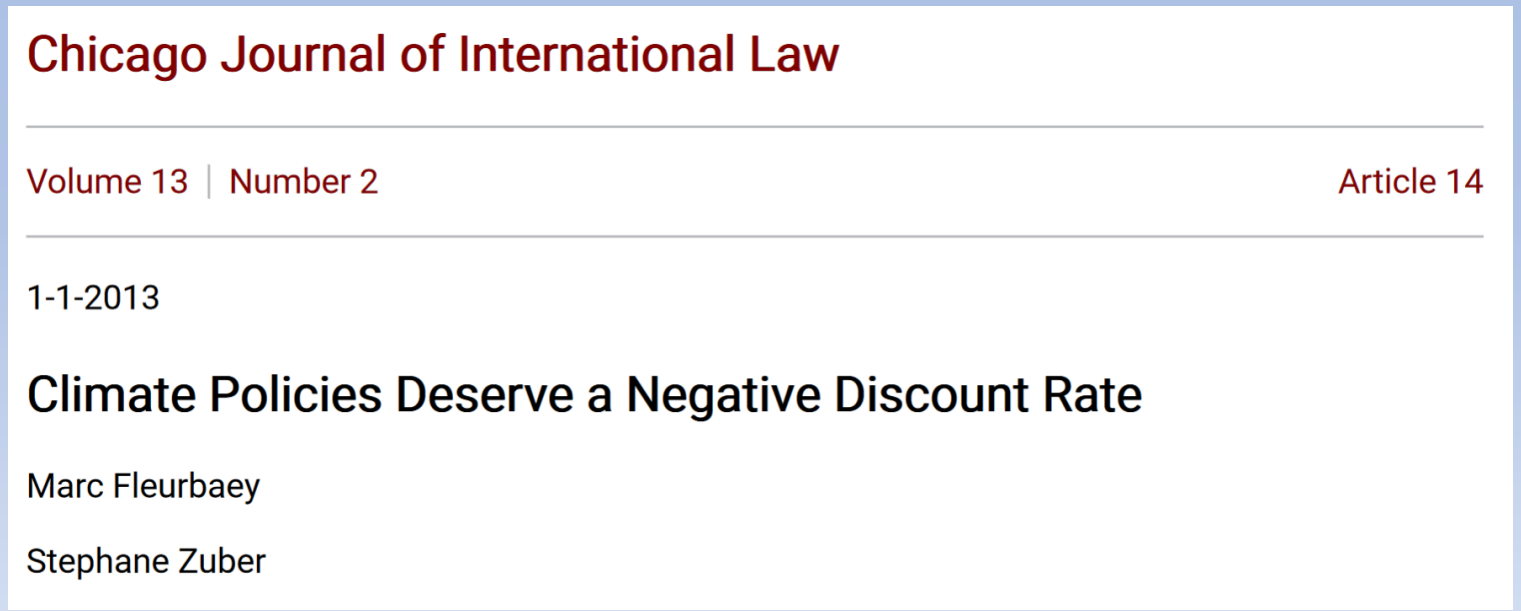
https://www.valuepenguin.com/average-commercial-real-estate-loan-rates (12/15/19)

Discount Rate : Profit Seeking Business Minimum Attractive Rate of Return (MARR)

*"In **business** and for engineering economics in both industrial engineering and civil engineering practice, the **minimum acceptable rate of return**, often abbreviated MARR, or **hurdle rate** is the minimum rate of return on a project a **manager or company is willing to accept** before starting a project, given its risk and the **opportunity cost** of forgoing other projects."*
https://en.wikipedia.org/wiki/Minimum_acceptable_rate_of_return (12/15/19)

*"For **most corporations**, the MARR is the company's **weighted average cost of capital** (WACC). This figure is determined by the amount of debt and equity on the balance sheet and is **different for each business."***
https://bizfluent.com/how-7864929-calculate-marr.html (12/15/19)

Discount Rate : The Social Discount Rate



Chicago Journal of International Law

Volume 13 | Number 2 Article 14

1-1-2013

Climate Policies Deserve a Negative Discount Rate

Marc Fleurbaey

Stephane Zuber

RCW 19.27A.210 (1) (b) In developing energy performance standards, the department shall seek to maximize reductions of greenhouse gas emissions from the building sector.

Discount Rate : Northwest Power and Conservation Council (NWPCC) – 7th Plan

The Seventh Power Plan covers 2016 through 2035,
with a six-year action plan period of 2016 through 2021.

In order to reflect both **descriptive** and **prescriptive** approaches, and given that the use of either corporate or consumer perspectives makes no material difference in resource selection, the Council used a real discount rate of **4 percent (4%)** for its analysis in the Seventh Power Plan.

This conversion has been a **key feature of Council analysis** from the first Power Plan; it is an **essential step** in the operation of the Regional Portfolio Model (RPM) today. The rate of time preference is also used in levelizing conservation measures' costs in Procost and generating resources' costs in Microfin.

- Chapter 8: Electricity and Fuel Price Forecasts – 4% discount rate applied to levelized cost
- Chapter 13 : Generating Resources - The key financial inputs used in the model for calculating levelized costs include: 1. Discount rate – 4%

NWPCC – Appendix A : Financial Assumptions and Discount Rate : Descriptive Approach

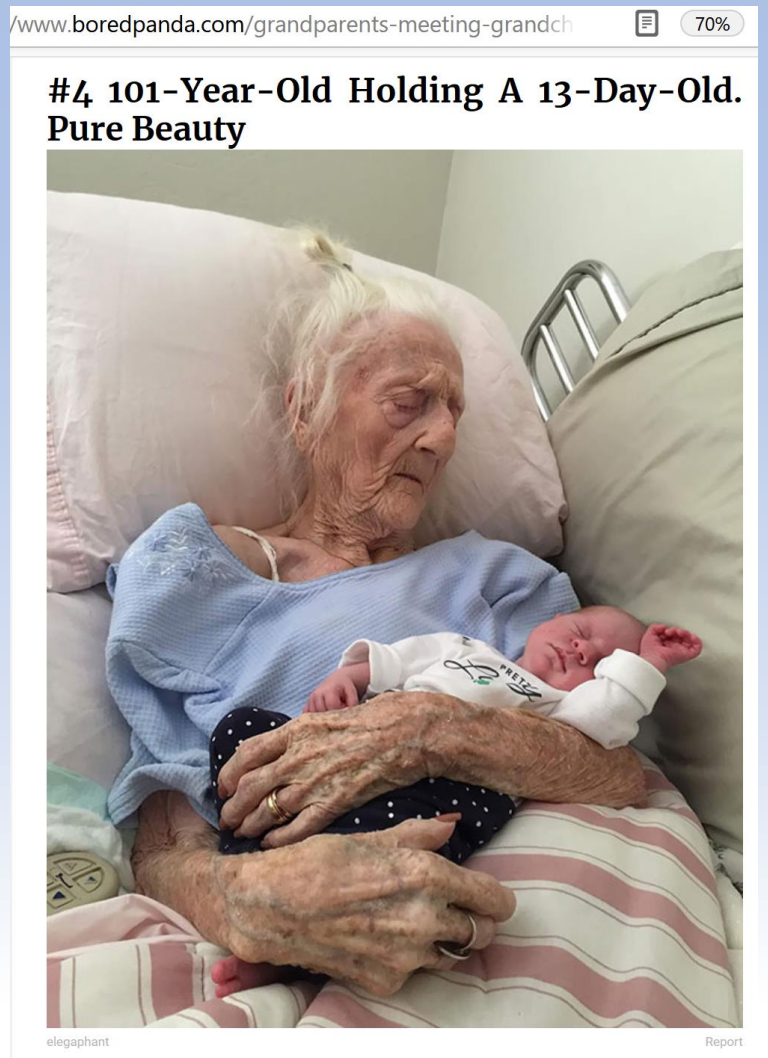
- Descriptive Approach (which focuses on decisions **observed in the market**): Because of this overall relationship between rates of time preference and interest rates, the level of the discount rate **should be related to the level of interest rates**. The difficulty is in determining **which interest rate is the appropriate** one for the choices being made. There are three general approaches commonly used for this choice, which can be described as the regional consumer's perspective, the corporate perspective and the national perspective.

Table A - 2: Inflation and Nominal Interest Rates on Common Investments

Item	2015-19 Average Nominal	2015-19 Average Real
GDP deflator	1.64%	
30 year Treasury	5.20%	3.5%
30 year new conventional mortgage	6.44%	4.7%
Long-term AAA municipal bond	5.24%	3.54%
Long-term Baa corporate bond	7.28%	5.6%

NWPCC – Appendix A : Financial Assumptions and Discount Rate : Prescriptive Approach

- Prescriptive Approach (which focuses on ethical considerations and market imperfections) : How then should society weigh my consumption now against that of my great-granddaughter 100 years from now? Does it make sense to weigh her consumption at less than 1 percent of mine, which would be the result of a 5 percent rate of time preference.



Three Discount Rates Arguments

- Opportunity Cost of Money (MARR) = **High**
  - 1% -> 100%+
- Cost of Borrowing (Nominal Interest Rate) = **Medium**
  - 1.5% Federal, 2-3% State, 5-6% Commercial, *12% High Risk
- Social Discount Rate (Public Good Policy) = **Low**
  - Generally less than 3%
  - Arguably a negative number

Lunch Time

Break-Out Discussions

1. Financial Hardship Criteria
2. Covered/Included Costs & Base-Case
3. Useful Life, Capital & Maintenance Costs
4. Discount Rate & Fuel Escalation Rates